Technology Transfer Brief

KOREA UNIVERSITY SEJONG CAMPUS

# An Architecture-Level Wrist Platform for Reliable and Scalable Robotic Manipulation


## Horsc Laboratory

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Jan. 2026

# Technology Transfer Brief

**An Architecture-Level Wrist Platform for Reliable and Scalable Robotic Manipulation**

## Content



# 01 Wrist Design Is a Structural Coupling Problem

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(*source: Popular Science, 2025)


*Unexpected object drop, Loss of stability at certain wrist angles, Inconsistent grasp during contact, Reduced reliability in repetitive tasks.*

- ✓ **Wrist architecture determines commercial reliability in high-load, contact-rich manipulation.**
- ✓ **Conventional wrist designs couple motion range, stiffness, and tendon routing, limiting design scalability and reliability.**

## Wrist Design Requirement

### ① ROM-Stiffness Decoupling

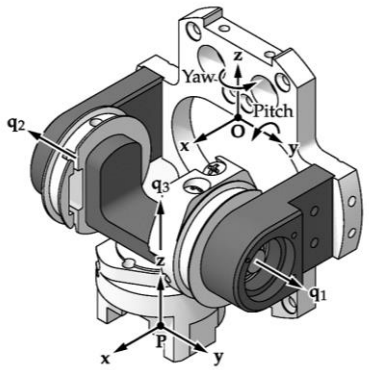
- Wide ROM
- High stiffness
- Dynamic stability
- Contact-ready

### ② Wire Routing Channel

- Dedicated routing volume
- Non-interfering paths
- Low torsion / bending within compact routing space
- ROM-independent routing

### ① Differential Serial Wrist

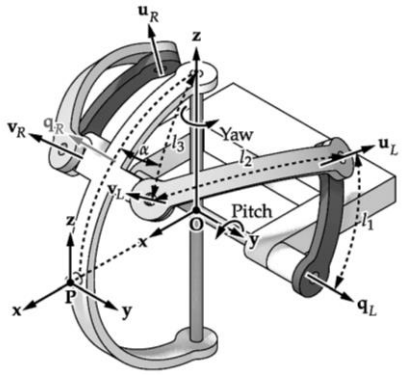
(iCub mk.2 wrist mechanism)




- ✓ Compact, Simple control, Humanoid-ready
- ✗ ROM-stiffness trade-off, Low dynamic rigidity, Routing as afterthought

### ② Spherical Parallel Wrist

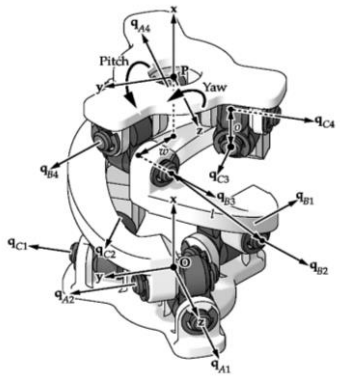
(Spherical six-bar mechanism)




- ✓ High stiffness, Load-capable, Accurate positioning
- ✗ Bulky structure, Limited routing space, Kinematic complexity

### ③ Singularity-Aware Wrist

(Quaternion joint mechanism)




- ✓ Continuous rotation, High dexterity, Kinematic continuity
- ✗ High system complexity, Poor integrability, Limited real-world use

# 02 Technology Overview

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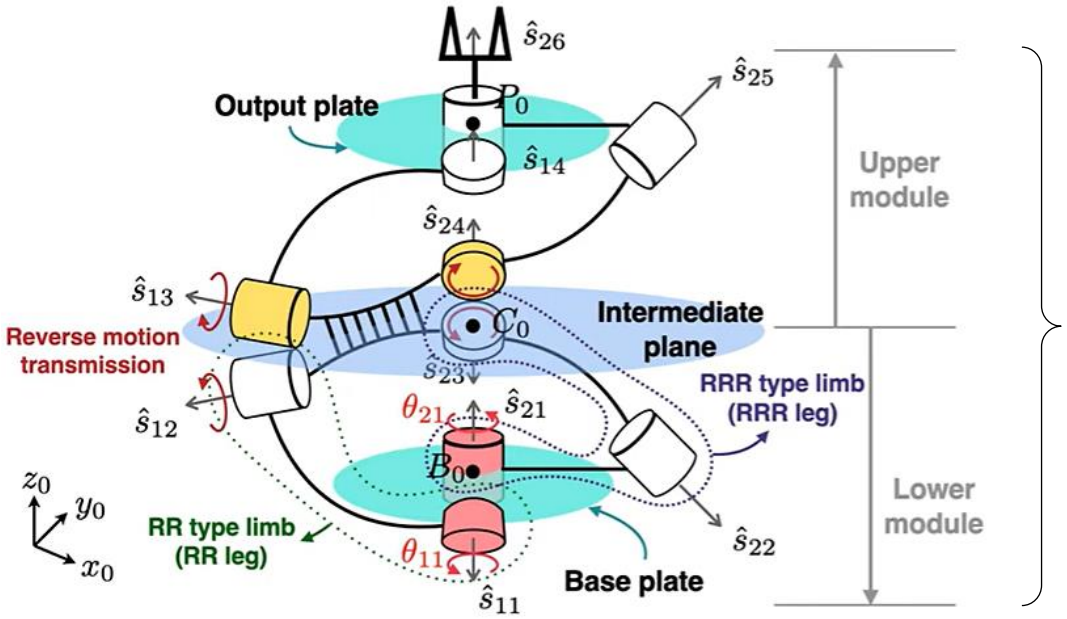
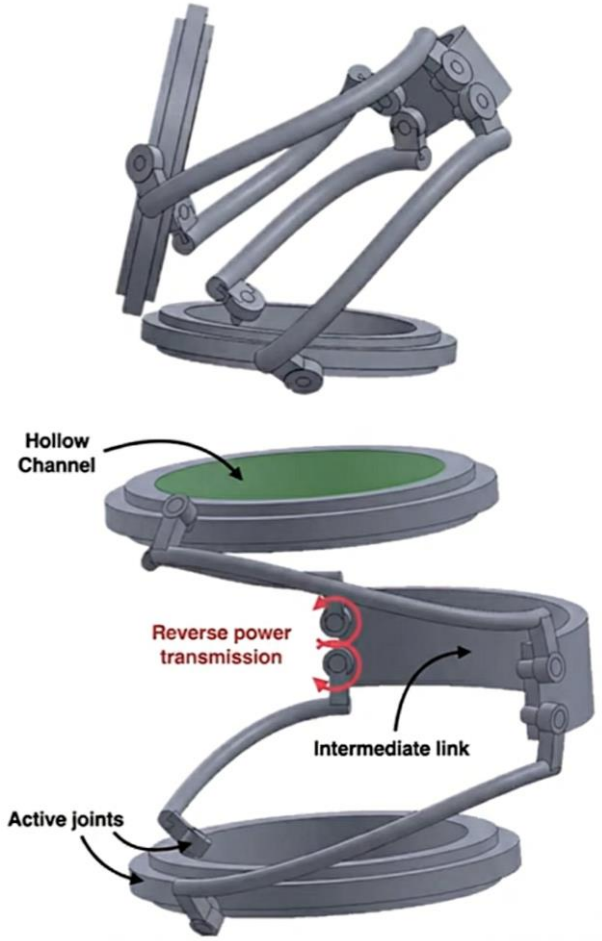
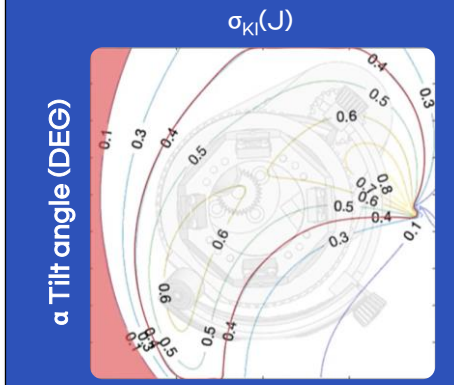
- ✓ **Design concept :** Structural decoupling of wrist tilt via parallel linkage and reverse power transmission.
- ✓ **Motion characteristics :** Consistent dexterity and load stability without abrupt performance degradation.



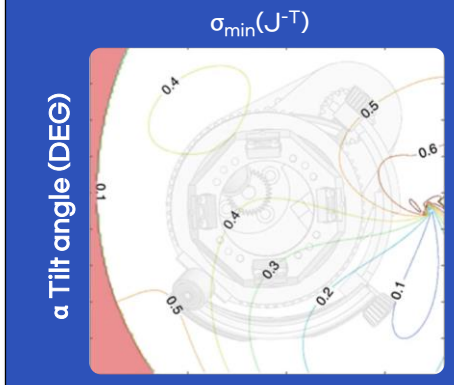

- The intermediate plane structurally cancels motion coupling, enabling both a wide range of motion (ROM) and high structural rigidity without the need for control compensation.
- A hollow routing channel maintains orientation-independent wire paths, improving scalability and reliability.

## Kinematic Isotropy Index



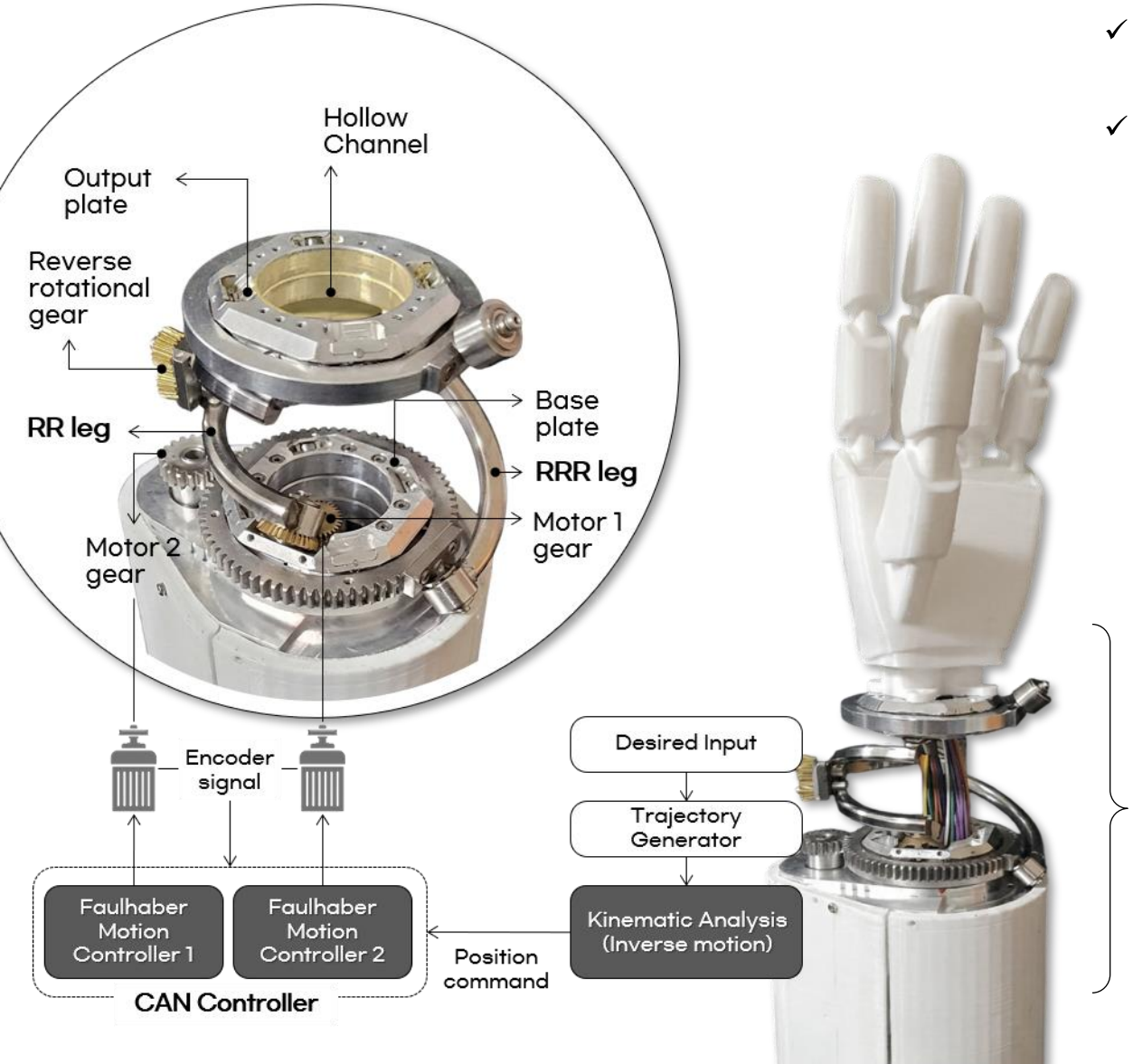

- Uniform manipulability (α-β)
- High & flat isotropy (center)
- Wide effective workspace ↑

## Minimum Payload




- Stable payload across task angles
- No abrupt drop ↓
- Localized weak zones only

# 03 Key Features & Advantages




- ✓ **An Architecture-Level Solution to Reliability and Integration Limits in Robot Wrists.**
- ✓ **Applications :** Humanoid robots, teleoperation systems, mobile manipulators, and tool-integrated end-effectors.

❶ **Structural Decoupling** with Load Stability

❷ Large **Hollow Channel** for Routing Scalability

❸ Task-Oriented **Isotropy** in the Usable Workspace

| Criteria | Gimbal | Omniwrist | Spatial parallelogram | Proposed wrist |
|---|---|---|---|---|
| DOF | 2 | 2 | 2 | 2 |
| Decoupling | Full | None | Full | Partial |
| Range of Motion | ±90° | Tilt 90° | P: -48°, +53°<br>Y: ±53° | P: -45°, +90°<br>Y: -65°, +50° |
| Hemispherical Workspace | Full | Full | Partial | Partial |
| Hollow Channel | None | Tiny | Tiny | Large |
| Kinematic Isotroy | Omni-directional isotropy | Omni-directional isotropy | Wide isotropy | Target-oriented isotropy |

# 04 Strategic Business Opportunities

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✓ **Business Vision :** An **architecture-level wrist solution** enabling reliable, scalable manipulation in contact-rich robotic systems.

✓ **Engagement Model :** Open to **technology licensing**, **collaborative R&D** partnerships, and potential **joint venture** formation.

## Collaborative development opportunities

### ❶ Architecture & Kinematic Performance Optimization

- **Scope :** Kinematic modeling and isotropy optimization of wrist architectures over wide orientation ranges.
- **Value :** Quantifies architecture-level performance advantages.

### ❷ Structural Decoupling & Reliability Design

- **Scope :** Structural decoupling design combining parallel mechanisms and load-path analysis.
- **Value :** Improves reliability under contact and load.

### ❸ Experimental Validation & Prototyping

- **Scope :** Prototype development and task-oriented experimental validation.
- **Value :** Reduces adoption risk for industry partners.

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**Horsc-lab**

Collaborative R&D
* Korean Government-Funded Programs

New Platform Design

Validation

**Robot Operator**

Co-dev.

Co-dev. (Platform-level)

IP license (Option/Exclusive)

Module supply

**Module/Subsystem Manufacturer**

- Wrist / End-effector module
- Mechatronic sub-assembly
- Upper-limb module vendor

**Robot System Integrator / Platform Developer**

(Humanoid, mobile manipulator, teleoperation system)

## Intellectual Property

- Title : PARALLEL MECHANISM
- Patent : US 18/163,553, KR 10-2506211

(Paper : Hyunhwan Jeong *et al.*, Development of a New 2-DOF Wrist Mechanism Using Reverse Motion Transmission, IEEE RA-L, 2021.)

CONTACT US

For inquiries regarding technology licensing, collaborative R&D, or partnership opportunities, please contact :

- Technology Transfer Agency : **IBU Inc.**
- Email : **kimth@ibubiz.kr**

# Partnering to unlock new business opportunities through innovation.


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